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ABSTRACT

Certain groups are underrepresented in mathematics courses and do not achieve to their potential. Black students and female students are among those groups. During middle school years boys begin to outperform girls in mathematics. White students begin to outperform black students even before the middle school years. Previous research has indicated that student attitudes and achievement-related behaviors are important in understanding the causes of differential mathematics achievement. This paper is based on a study of attitudes and achievement-related behaviors of 16 students in a seventh-grade mathematics classroom; the similarities and differences by race and sex. In this paper, discussion is limited to the attitudes of confidence in learning mathematics and achievement-related behavior of persistence in the mathematics classroom. Data gathering procedures are described. (DC)

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Attitudes and Achievement-Related Behaviors of

Middle School Mathematics Students:

Views Through Four Lenses

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The main objective of this study was to examine the attitudes and achievement-related behaviors of 16 students in a seventh-grade mathematics classroom. More specifically, we were interested in studying the similarities and differences in student attitudes and achievement-related behaviors by race and sex.

Knowledge of mathematics is essential for all members of our society. In order to participate fully in our democratic processes and to be unrestricted in career choice and advancement, individuals must be able to understand and apply mathematical ideas. Unfortunately, certain groups are underrepresented in mathematics courses and do not achieve up to their potential. Black students and female students are among these groups. This study contributes to our understanding of the attitudes and achievement-related behaviors that may affect this differential achievement.

Beginning during the middle-school years, boys begin to outperform girls in mathematics, especially on higher level cognitive tasks. The differences are not large, but they are worthy of our attention. White students begin to outperform black students even before the middle school years, and the differences are larger than those by sex. Previous research has indicated that student attitudes and achievement-related behaviors are important in understanding the causes of differential mathematics achievement. Examples of student attitudes important in mathematics are: confidence in learning mathematics, enjoyment of mathematics, perceived usefulness of mathematics, beliefs about the appropriateness of mathematics as

an area of study, and attributions of success and failure in mathematics. Examples of mathematics achievement-related behaviors are: persistence, independence, and the election of optional mathematics courses. Significant differences in the above attitudes have been documented for boys and girls and suggested for students of different races. The size of sex and race differences in the achievement-related behavior of course-taking reflects the size of the respective achievement differences (Reyes & Stanic, 1988). Further work is needed to clarify the attitude differences by sex that have been documented using only paper-and-pencil instruments and to test the suggested attitude differences by race. There is also a need to examine possible sex and race differences in the achievement-related behaviors of persistence and independence.

In our case study, we focused on all of the attitudes and achievement-related behaviors mentioned above. For the purposes of this presentation, we will limit our discussion to the attitude of confidence and the achievement-related behavior of persistence.

Confidence has been discussed a great deal in the mathematics education research literature. We know, for example, that there is a sex difference in confidence among white students. The difference between black students and white students in confidence is not as clear across age levels, and the sex difference among blacks has not been studied. At least in the classroom we studied, it is clear that one must look at both race and sex to understand the importance of confidence in

learning mathematics.

Persistence has not been studied in mathematics education research to the extent confidence has. In fact, the main task now seems to be to determine what, exactly, persistence might mean in the context of a mathematics classroom. In the classroom we studied, it was easier to find examples of students quickly giving up on a problem than it was to find positive examples of persistence on one's own in the face of difficulty because the children were given few opportunities to persist in this way.

Data Gathering Procedures

Attitudes and achievement-related behaviors were examined using four data sources (or "lenses"): paper-and-pencil instruments, classroom observations, student interviews, and teacher interviews. Measures of achievement include numerical course grades assigned by the teacher, grades on specific classroom tests, and scores on standardized achievement tests.

A "high average" (the second highest of the achievement groups in the school) seventh-grade mathematics classroom was studied during a period of three months (October to January). The class, which was taught by a black male teacher, had 17 students; parental permission to gather data was obtained for 16 of them. The 16 students comprised 4 black females, 3 black males, 5 white females, and 4 white males. The data came from field notes and audio recordings of 45 class sessions, a half-hour audiotaped interview conducted with each student, student attitude questionnaires (Fennema & Sherman, 1976; Fennema & Peterson, 1984), 5 half-hour audiotaped interviews conducted with the teacher, artifacts gathered during the classroom observations

(e.g., copies of tests and homework papers), and student permanent school records. Both of us observed almost all of the 45 class sessions and conducted all the interviews.

Mathematics Achievement

We used six measures of achievement in our study, four classroom measures (Grade 6 final grade, Grade 7 November test grade, Grade 7 January test grade, and Grade 7 second quarter grade) and two standardized achievement measures (Grade 6 Iowa Test of Basic Skills [ITBS] overall mathematics percentile and Grade 7 American Junior High School Mathematics Examination [AJHE] score). On all six measures, the mean for the white students in the class was higher than the mean for the black students, with the differences on the two standardized achievement measures greater than one-half of a standard deviation and the differences on the four classroom measures less than one-third of a standard deviation. The pattern by sex changed over time. On the first three measures (Grade 6 ITBS overall, Grade 6 final grade, and Grade 7 November test), the female students had higher means than the male students. On the last three measures (Grade 7 AJHE score, Grade 7 January test, and Grade 7 second quarter grade), the male students had higher means than the female students. Again, the differences on the standardized achievement measures were greater than one-half of a standard deviation, and the differences on the classroom measures were less than one-third of a standard deviation.

Interestingly, the students in this seventh-grade classroom reflect the patterns of race and sex differences for the nation

described earlier. That is, race differences in mathematics achievement in favor of white students already exist by the middle school years; sex differences in favor of males begin to appear during the middle school years.

Perhaps as important as the sex differences and the race differences in the classroom we studied was the pattern of achievement among the sex-by-race groups. Grade 6 final grades (maximum score 100) showed black females highest (88), followed by white males (87), white females (84), and black males (80). On the three Grade 7 classroom measures, white males and black females scored highest (with white males having a slightly higher score on two of the measures), followed by white females and black males. The standardized test scores were somewhat different. On both the ITBS and AJHE, white males scored highest, followed by white females, black females, and black males. On the ITBS, the black males stood out with a particularly low percentile compared to the other three groups (a percentile of 57 compared to percentiles in the 70s). On the AJHE, the white males stood out with a particularly high score compared to the other three groups (a percent score of 33 compared to percent scores in the low 20s).

Overall, then, the white male students in the classroom we studied were at or near the top of the four sex-by-race groups for both classroom and standardized achievement measures, and the black male students were at the bottom. The black female students did better on classroom measures than did the white female students; the order was reversed on standardized achievement measures. We do not know how this sex-by-race

pattern compares to the nation as a whole because national data, while they exist in the files of the National Assessment of Educational Progress, have not been reported for sex-by-race groups. Our data do fit with at least one study (Yando, Seitz, & Zigler, 1979) that reported black female students achieving at a higher level than black male students.

Confidence in Learning Mathematics

Although the pattern of achievement by race and by sex in the seventh-grade class we studied reflects the national pattern, the same correspondence does not occur when we look at the attitude of confidence. For example, in the fourth mathematics assessment of the National Assessment of Educational Progress (NAEP 4), in Grade 7, white students demonstrated more confidence than black students and males demonstrated more confidence than females. In our classroom, results from the Fennema-Sherman confidence scale showed the opposite pattern. That is, blacks scored higher than whites (with the difference being more than one-half of a standard deviation), and the females scored higher than males (by less than one-third of a standard deviation). Again, we found that looking just at race or just at sex was misleading. In fact, what stood out in the Fennema-Sherman confidence scale results was the fact that the black female students scored so much higher than any of the other three groups, almost a full standard deviation higher than the next highest group, the white males.

Furthermore, the sex differences in confidence were in opposite directions in the two racial groups. White males scored

almost one-half of a standard deviation higher than did white females. Black females scored more than a full standard deviation higher than the black males.

The student interviews confirmed some but not all of the paper-and-pencil results. For example, both the male and the female black students spoke confidently about their ability in mathematics, confirming the difference in favor of blacks we saw on the paper-and-pencil instrument. Unlike the result from the Fennema-Sherman scale which showed the black females standing out from the other three groups in a positive direction, the interviews led us to conclude that the white females stood out from the other groups as being much less confident in their mathematical ability. This conclusion from the interviews is especially important in light of the fact that all four groups had demonstrated a substantial amount of confidence on the Fennema-Sherman scale: For example, the mean scores for all four groups were higher than any mean reported by Fennema and Sherman (1978) in their study of middle school students.

During our interviews, the white females were not just less confident, but often negative about their mathematical ability. For example, Wendy, who was clearly a very capable mathematics student, based both on her achievement scores and on our observations of her, said she was "pretty bad" in math and claimed that just adding, subtracting, multiplying, and dividing confused her. She said she worried a lot about tests and believed she was lucky to do as well as she did because, in her words, "I'm not good at math." We do not want to paint an exclusively negative picture about Wendy's confidence. For

example, when asked whether, in the end, she could figure things out, she said, "Yes, I am good at figuring out things, but it takes me a little while in math." Wendy earned mostly Bs and believed that the fact that she did her homework, studied a lot, and kept her notebook neat covered up for some of the problems she perceived herself as having.

At times it was difficult to judge the level of confidence of a student because of the way in which confidence seemed to interact with other attitudes such as enjoyment, perceived usefulness, and attributions of success and failure. Chris provides a good example. She was the most successful white female student in the class and was described by her fellow students during interviews as being unpopular. The teacher identified Chris as one of the two students in the class he would consider moving to the accelerated mathematics group for seventh graders. When we asked Chris how she would compare herself with other students, she said: "Sort of medium. Not really real super duper good. Not real real terrible awful bad. Just sitting there, average." We asked her why she was average and how she could get to be above average and she said: "I could try a whole bunch harder and study a whole bunch more and maybe really cover the stuff." She said when she felt sure of something, she didn't bother to go back over it because it was boring to her. When asked what makes some people better in math, she said part of the reason is that some people have a "talent" for math, and later admitted that she had "maybe a little bit" of talent. Chris also said that some people are better in

mathematics because they really care about it, and then indicated she really did not care: "I think in math you need to know the basics. Any more is a waste of time." The point is that in Chris's case, we saw that her relatively high Fennema-Sherman confidence score did not adequately describe her confidence in doing mathematics. Furthermore, the interview with her indicated that for Chris, confidence was not as important an attitude as was her view of mathematics as something she did not enjoy doing and something that had limited usefulness. Because her level of confidence clearly interacted with these other attitudes, it is not easy to say exactly how confident in her ability to do mathematics Chris was.

This characteristic of Chris also points to the difficulty of making connections between attitudes and achievement. We noticed in classroom observations that Chris's attitudes did, in fact, lead to her learning less mathematics than she might have. For example, when she finished a task, rather than letting the teacher know she was done, she was content to sit at her desk and read a novel she had brought with her to class. The classroom teacher often did not notice Chris at such times and, when he did notice, allowed her to continue reading her book. The teacher jokingly commented in an interview about the number of novels Chris completed in his class, but he sometimes could not remember her name when we talked about her. Despite the extensive amount of time when Chris was not doing mathematics, she was among the highest achievers in the class. So her attitudes did not hamper her in successfully completing the tasks in this particular classroom. What we worry about is the cumulative effect of such

attitudes and neglect over time on a student who to us appeared to be capable of much deeper understandings of mathematics and who was exactly the kind of student who needs encouragement to continue to take mathematics courses. And this is one reason why a correlation coefficient does not adequately describe the relationship between attitude and achievement. To understand this relationship, researchers really need to study people over time and attitudes in interaction.

Persistence in the Mathematics Classroom

We used two items from the Fennema-Sherman effectance motivation scale as indirect measures of persistence: "If I can't solve a math problem right away, I stick with it until I do" and "I would rather have someone give me the solution to a hard math problem than to work it out for myself." Ratings were adjusted so that high means meant high persistence. On both items, black students had a higher mean than white students, by about one-third of a standard deviation. Males had a higher mean than females on the "I stick with it" item, by more than three-fourths of a standard deviation; on the "give me the solution" item, females scored higher by less than one-fourth of a standard deviation. In the race-by-sex groups, black males stood out as higher on the "I stick with it" item than any of the other groups, with a mean that was almost a full standard deviation higher than the next group. On the "give me the solution" item, black females had the highest score, about a third of a standard deviation higher than the next group. This sex-by-race pattern accounts for both the black-higher-than-white results and the

mixed sex results across the two items.

The interviews, another indirect measure of persistence, and our observations of persistence in the classroom confirm the paper-and-pencil results when we look at the individual students who seemed to be low in persistence. The seven students in the class we judged to be lowest in persistence comprised three white females, two white males, one black female, and one black male.

Both the paper-and-pencil items and our classroom observations pointed to the problems of defining persistence and determining the relationship between persistence and achievement in the mathematics classroom. Tim, a white male and the dominant student in the class, is a good example. Tim had the highest scores on both of the standardized measures of achievement we used and was at or near the top on the four classroom measures. He was viewed by his fellow students and the teacher as the best mathematics student in the class. He dominated class discussions, was called on most often by the teacher to answer difficult mathematics questions, and gave a running commentary during class sessions on the performance of his peers. He was, in effect, the "answer key" for the teacher and was a source of great annoyance to most of his classmates. Tim strongly agreed with the item that said "I stick with it," but he also strongly agreed with the item that said "I would rather have someone give me the solution to a hard math problem." Although the responses appear contradictory on the surface, a closer look at the items and our classroom observations of Tim make the responses appear reasonable and consistent with his actions.

Tim did not continue to struggle with a problem on his own

in all situations when confronted with mathematical difficulties; in fact, he was sometimes quite willing to give up. What was reflected in his effort was not so much persistence in solving mathematical problems on his own as it was an urge to get his work done as quickly as possible. When giving up on a problem and asking the white male student he worked with or the teacher for help would likely lead to finishing his work more quickly, Tim was quite willing to seek out help. Persisting on his own was not always important to Tim because doing well did not only mean getting a good grade on an assignment. In fact, getting done quickly was consistently the most dominating factor for Tim, so much so that he would sometimes announce he was done even before he had actually completed all of the assigned work. So Tim may have interpreted the idea of "I stick with it" in the first paper-and-pencil item as getting the correct answer in any way he could and as fast as he could. This approach is quite compatible with wanting someone to give him the answer to a hard problem, his response to the second paper-and-pencil item.

The above analysis of Tim's behavior in the classroom is a bit misleading because Tim rarely had to face a hard problem. He could quite easily handle almost all the assignments the teacher gave. So he had only rare opportunities to demonstrate his willingness to struggle on his own, but when he did have the opportunity, his choice was usually to seek out help in order to finish the assignment quickly.

One reason for the difficulty in determining the relationship between persistence and achievement is that

continuing to struggle on one's own in the face of difficulty is rarely encouraged or observed in mathematics classrooms, including the one in our study. It was easier for us to find examples of a lack of persistence than it was to find positive examples of persistence in the face of difficulty because the level and pace of instruction discouraged this kind of struggle.

Both the higher and lower ability students in the class rarely demonstrated persistence. The higher ability students, such as Tim, had almost no opportunity to struggle with a mathematics problem because most of the work was easy for them; the lower ability students did face difficulties but had little opportunity to struggle on their own because of the pace of instruction. Furthermore, the students were never taught how to deal with difficulty other than to immediately ask for help. The goal in the class we studied was clearly not to learn through struggle but to get answers and complete assignments. The children did not really have to struggle to get an answer, especially on those tests and assignments which were presented in a multiple choice format.

So, in a classroom situation, persistence cannot be judged based simply on whether or not children get an answer, because getting an answer is, in effect, required of everyone. However, we also should not judge children's persistence based on whether or not they struggle on their own to get an answer, because struggling on your own is not always the most intelligent choice in a mathematics classroom. Although persisting on one's own may be a virtue, the time constraints of the mathematics classroom and the pace of instruction can make this kind of persistence an

impediment to achievement. Even in non-classroom situations when a person is given a task with no time constraints, this kind of persistence is not always constructive. That is, it may be valuable to leave a problem for a while and come back to it later. But in a mathematics classroom, that option is typically not open for children. So an individual student has to balance her or his urge to continue to struggle with a problem with the need to complete the page of problems and go on to the next assignment. Getting help in a classroom, either from peers or from the teacher, may not, then, be a sign of lack of persistence as much as it is a reasonable choice within the constraints of the classroom.

It is clear to us that more struggling on your own in the face of difficulty needs to be encouraged in mathematics classrooms. However, our study of this classroom leads us to conclude that we may need to think of persistence differently, or to think of different kinds of persistence, because children and teachers will always have to deal with time constraints in some form. For example, we may need to more clearly separate persistence from independence and look for persistent attempts to understand rather than persisting on your own when faced with a hard mathematics problem. We could then attempt to judge the level of persistence demonstrated during interactions with others. We might ask, for example, does the child struggle to understand the concept during the interaction, or does she or he simply want to get an answer? Our classroom observations told us enough to know that there are important differences among

children in how they act during mathematical interactions with the teacher and their peers, but we really did not focus enough on those different interaction styles to make more specific conclusions. In our next study of a classroom, we intend to examine these different forms of interaction and use the results to help us better define what persistence might be in the mathematics classroom.

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